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THE NORTH CAROLINA
COLLEGE OF AGRICULTURE AND MECHANIC ARTS
AGRICULTURAL EXPERIMENT STATION DEPARTMENT
GEO. T. WINSTON, A.M., LL.D, DIRECTOR

IMP. ENTOM. MAY. 1914 C.M. Goodwin

Gardening Under Glass

I. AN EXPERIMENT IN TOMATO FORCING.
By W. F. Massey and A. Rhodes.

II. THE USE OF GLASS IN GARDENING FOR THE MARKET.
By W. F. Massey.

WEST RALEIGH, N. C.
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THE NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION DEPARTMENT

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LETTER OF TRANSMITTAL.

N. C. College of Agriculture and Mechanic Arts.
Experiment Station Department,
Division of Horticulture, Etc.

Dr. Geo. T. Winston, *President and Director.*

Dear Sir:—I beg herewith to submit for publication a manuscript giving an account of the experiment made during the winter just past in testing the respective values of a number of varieties of tomatoes for forcing under glass in winter.

There is a great increase of interest among our market gardeners, especially in the eastern part of the State, in winter gardening. I have therefore added some hints on the use of glass on frames and in temporary greenhouses, hoping in the future to deal with the subject of Winter Forcing in the South in a more exhaustive way.

Trusting that the Bulletin may aid some who are now struggling with difficulties in gardening, I am

Very respectfully,

W. F. Massey

Horticulturist, etc.

Winter Forcing of Tomatoes.

By W. F. Massey and A. Rhodes.

INTRODUCTORY.

The work detailed in the following pages is a continuation, to some extent, of experiments in the winter forcing of tomatoes that have been in progress for the past three seasons. The main difference in the work the past winter and that of the previous winters has been that during this season it has been a study of the adaptability of varieties for this purpose, and also a study of methods of pollenation.

Heretofore the object has been to ascertain the practicability of the culture here as a commercial matter. That is, whether the forcing of tomatoes can be made a profitable business.

It has been evident from the former tests that with houses built especially for the purpose, and better adapted to forcing than the houses we have used, there will be a fairly profitable business. That a man engaged in a general floricultural business can profitably use a portion of his glass for winter forcing until the advancing spring season requires the use of all the glass for the production of bedding plants for his spring trade. Managed in this way, the florist could grow tomatoes and beans and strawberries very profitably during the part of the season when he did not need the use of all his glass. Of course it would be a question of individual conditions, for it may pay the florist to use the glass for forcing cut-flowers rather than tomatoes, and one so situated would of course grow that which is most profitable under his conditions. But there are many so situated that the cut-flower trade is of little importance to them, and yet who are favorably located for shipping winter forced vegetables.

There are few large towns where a local trade of this sort can not be easily established to a certain extent. Grown to the extent we have grown them, the tomato crops during the winter can be profitably disposed of in the local market, and there is not a large town in the State where the same thing can not be done to a limited extent.

There are always in such places a few people who are willing to pay a fair price for a good article, and we have found no difficulty in disposing of tomatoes in direct competition with the Florida product at a far better price, because of the superior quality of the product grown under glass.

VARIETIES TESTED.

The object of the experiment being to determine the respective value of different varieties of tomatoes for winter forcing, a number of sorts were planted. The seeds were all sown the same day, and in every respect the plants had the same treatment. The following varieties were planted: Matchless, Perfection, Maule's Imperial, Maule's New Forcing, Stone, White's Excelsior, Fordhook Fancy, Purple Advance, and Maule's Earliest.

The most popular tomato for winter forcing has been the Lorillard. In previous experiments we grew this variety and the Dwarf Champion with the result that in our method of growing, the Dwarf Champion invariably gave the best results. With a different method of culture the case might have been reversed, since all our forcing has been done in ten-inch flower pots. In the test made of a few varieties in 1898-99, the Essex Hybrid gave the best results as a cropper, and also in the smoothness and perfect setting of the fruit.

THE FORCING HOUSE.

The house used for these experiments is part of the range of glass at the college, and consisted of a house 20 x 60 feet. It is an even span house, running north and south. The house is supplied with an abundance of hot-water piping, so that, if necessary, a night temperature of 70 degrees can be maintained in the coldest weather, though this temperature is not needed in tomato forcing, the usual night temperature used being from 55 to 60 degrees. The whole house was devoted to tomatoes, but the plants used in the variety test occupied the middle bench alone.

Twelve plants of each variety were grown for the comparison.

METHOD OF CULTURE.

The seeds were sown in flats September 5, 1899, and potted into three-inch pots as soon as large enough to handle. When well

established in these pots they were transferred into four-inch pots, and from these into the fruiting pots of ten inches. The soil used was a mixture of one-half our ordinary potting compost and one-half Jadoo fibre.

The Jadoo fibre is a newly invented potting material made by steaming peat moss with chemicals, forming a black, fibrous mass that retains moisture well, and has a good mechanical effect when mixed with the potting soil, favoring the development of the root system to a remarkable degree. It was used mainly for its mechanical effect as there is great difficulty here in getting good turf for potting compost, and some mixture of fibrous material with the earth we are compelled to use is a great advantage.

In transferring the plants from the four-inch pots into the ten-inch ones, care was taken to supply an abundance of drainage by placing crocks in the bottom and covering them with the Jadoo fibre. The compost was then filled in only to the height of the four-inch ball. As soon as new roots could be discerned penetrating the fresh compost, an additional layer of the compost was given, an inch thick. Thereafter successive layers were added as fast as new roots appeared in the last layer, until the pots were sufficiently filled.

Managed in this way the plants developed a great mass of roots, and were soon completely filling the ten-inch pots, and in this condition were in shape to take up additional nourishment, which was given by watering with liquid fertilizer made from the Jadoo liquid, reinforced with a small quantity of nitrate of soda.

The plants were trained strictly to a single stem, each being trained to a reed stake stuck in the pot and attached at the top to horizontal reeds so as to make a stiff trellis.

In previous experiments this house has been found badly infested with Cladosporium fulvum, which the winter before destroyed nearly all the foliage, and made the result of no value. Therefore special effort was made this season to prevent the attack of the fungus, as it was found totally impracticable to get rid of it when once in. The plants were sprayed with sulphide of potassium in a weak solution, and the hot-water pipes were painted over with a wash of lime and sulphur. There was a strong sulphurous odor at times in the house,

when firing was going on, and there was no appearance of the fungus on any plant in the house.

It is believed that the lime and sulphur that was on the pipes will of itself prevent the development of fungus, but in order to prevent an attack before the weather is cold enough to fire the boilers, it is well to use the sulphide one ounce to two gallons of water.

Care should be used in spraying, as the chemical will blacken white paint wherever it touches it. Prevention should always be the rule in combatting fungus disease in any plant, for after the invasion has gone so far as to develop the fruiting spores, the case is beyond help.

Our complete freedom from disease the past winter in a house badly infested the winter before, shows the importance of prevention.

VARIOUS METHODS OF FORCING.

We have used flower pots for forcing tomatoes, because it was not practicable to arrange our houses for planting out in soil on the benches. In most cases this planting in beds of soil on the bench is practiced. Others use large wooden boxes for growing the plants. We have in past years tried both of these plans, but under the conditions in which we are compelled to work, we prefer to use the ordinary earthenware pots. The bench on which the pots stand is covered an inch or more deep with coarse sand. This not only assists in the free drainage of the pots, but helps to preserve moisture in the air, since syringing overhead is impracticable with tomatoes, and yet moisture must be maintained in the house to keep down the red mites, which would soon destroy every leaf in an arid atmosphere.

Plants grown in pots require closer attention to watering than those in boxes or on the bench, but this makes the culture a valuable help to the young men who were engaged in the work, in the study of moisture conditions and proper watering under glass.

RESULTS.

Being not only a variety test, but a study of methods of pollenation, the total crop was not as large as it might be made by an exclusive growth of a variety well adapted to forcing, and the use of the best method of setting the fruit. The table shows the amount of fruit gathered each day from each variety.

Number of plants in each case 12.

Variety.	Dates of Gathering.	Weights.	
		Lbs.	Oz.
MATCHLESS	January 26		9½
	February 3	3	12
	" 10	1	2
	" 14	2	12
	" 20		7
	" 24		12
	March 1		7
	" 9		6½
	" 14		13
	" 22	1	7
Total		12	8
MAULE'S IMPERIAL	January 13		3½
	" 18	1	1
	" 26	4	9½
	" 30		5½
	February 3	2	3½
	" 8		15½
	" 9		9
	" 10	1	10½
	" 14	2	7
	" 24		12½
	March 9		11½
Total		15	10
PERFECTION	January 13		12
	" 18	1	12½
	" 20		4
	" 26	1	4
	February 3	1	10½
	" 9	2	9
	" 10	1	1
	" 14	1	10
	" 24		2
	March 1		6
	" 14		6
Total		11	13
MAULE'S NEW FORCING	January 18	1	11½
	" 20	1	3
	" 26	3	15½
	February 3	1	10
	" 10	1	9¼
	" 14	2	14½
	" 20	1	6½
	" 24		6½
	March 9	1	3
	" 14		13¼
	" 22		10
Total		17	6

Variety.	Date of Gathering,	Weights	
		Lbs.	Oz.
STONE	January 13		1¾
	" 18	3	1½
	" 20	1	5
	" 26	4	5½
	" 30		9½
	February 7		15
	" 10	2	2¼
	" 14	1	5
	" 20		4
	March 1	1	1
	" 9	1	7
	" 14		5½
	" 22		6
Total		17	12
WHITE'S EXCELSIOR	January 13		2¼
	" 18	2	9¼
	" 20	1	5
	" 26	3	15
	" 30	1	
	February 3	1	10
	" 10	1	10
	" 14	1	7
	March 1		11
	" 9		14½
	" 14		10
Total		15	14
PURPLE ADVANCE	January 9		15
	" 13	1	11
	" 18	2	2
	" 20	2	3
	" 26	1	6
	" 30		1
	February 3	2	4
	" 10		9
	" 14		5
	" 20		12½
	" 24	1	5
	March 1		9½
Total		13	7
FORDHOOK FANCY	January 13		4½
	" 18	2	10½
	" 20	1	
	" 26	5	5¼
	" 30		3½
	February 10		6
	" 14		4½
	" 20		6½
	" 24		4
	March 2		13½
	" 9		5
	" 14	1	2½
	" 22		6½
Total		13	8

Variety.	Date of Gathering.	Weights.	
		Lbs.	Oz.
MAULE'S EARLIEST	December 25		12
	January 9	2	7½
	" 18	2	10
	" 20	3	14½
	" 26	4	12
	" 30		5
	February 3	2	2
	" 10	2	4
	" 14	1	1
	" 24		2
	March 1	1	2
	" 9		4½
	" 14		10½
Total		22	7

DESCRIPTION OF VARIETIES.

Matchless.—A large and showy tomato, uniformly smooth and solid. Color, a deep, rich, bright red. Plant a vigorous grower, but better suited for open air culture than for forcing.

Maule's Imperial.—Large in size, perfectly smooth and solid, and if carefully fertilized would make an admirable forcing tomato. Color, a rich, glossy, purplish crimson. Well worth further trial, both under glass and outside.

Perfection.—One of the Livingston tomatoes, and not a new one. It is a rich, red tomato, smooth and solid, and of good size, but is too poor a setter of fruit for profit. We have found the same fault with it in the open air.

New Forcing.—This variety was sent for trial without name, by W. H. Maule, of Philadelphia. It makes very smooth and handsome fruit of a brilliant red color, and we will give it further trial. With us it has done as well as the Lorillard, under similar conditions.

Stone.—Fruit very smooth and solid. Color, bright red. Fairly good, smaller than the last one, but rather more fruitful. One of the best in open air culture, and worthy of further trial under glass.

White's Excelsior.—Fairly early for so large a tomato, but rather a poor setter under glass. Decidedly the most showy tomato of the whole lot, and may do better with careful hand setting. Color, purplish red. A superb fruit, and worth trying further.

Purple Advance.—An early, deep purple colored tomato, but entirely too small for profit under glass. Not worth growing in the house, but its earliness may give it some value out doors.

Fordhook Fancy.—This has the broad potato-leaf foliage, and the habit of the Dwarf Champion. The fruit is not very large, but is decidedly the most handsome in appearance of any grown. Color, a rich, glossly, purplish red. Too unproductive for profit anywhere, and only valuable as a fancy tomato in small gardens.

Maule's Earliest.—This is the earliest tomato we have ever tested. Fruit of large size and bright red in color. In its present condition it is unsuited to forcing, though by far the most productive of any, because of its irregular and uncouth shape. No tomato we have ever grown excels it in productiveness, at least no large one. If it can be bred into a uniformly smooth shape and retain its other good qualities, it will be an invaluable tomato for forcing or for open air culture. We intend to work with this variety with the hope of curing its one bad characteristic. Once bred into a smooth fruit, it would leave little to be desired in a tomato, as its color is of the brightest and its flesh solid and fine. It seems to us to be the starting point for a tomato of remarkable value for the market. Some of our plants made uniformly smooth fruit, but the majority were very irregular. We propose to remove some of the smoothest plants from surrounding influences by propagation from cuttings and from these to select seed, hoping finally to establish a heredity of smoothness by careful selection. It is the most profuse blooomer of any tomato tried, and if the whole product had been carefully hand pollenized, the crop would have been much larger. There is, in our opinion, more of promise to the trucker in this tomato than in any under test, and we believe it can yet be made the forcing variety of all others.

POLLENATION.

An inspection of the figures given will reveal the fact that after the 26th of January, there was a general falling off in the product. This was not caused by any decrease of vigor in the plants, but simply by the lack of perfect pollenation. All the fruit that ripened up to the 26th of January had been carefully fertilized by hand with a camel hair brush. Most writers on the subject of tomato forcing

advise the shaking off of pollen in a spoon, and then applying it to the pistil. Whether anyone ever did this I can not say. Certainly we did not succeed in doing anything of the sort. But we did succeed in pollenizing perfectly by wiping off the pollen with a camel hair brush, and applying the brush, bloom by bloom, to the pistils. Other writers have said that it is sufficiently to daily jar the blooms by tapping them about noon daily. With a view to test the difference we, after the first few fertilizations with the brush, had the blossoms jarred daily. The result was an imperfect setting of the fruit and a rapid falling off in size, and hence a reduced crop from what it would have been had the careful hand fertilization with the brush been continued. There may be conditions under which the pollen will shake off, but we never found it in any such condition. With us the camel hair brush is the only reliable pollenizing implement.

Of course under the conditions of this test no conclusions can be drawn as to the profit in a commercial way of forcing tomatoes. We hope another season to make a complete test with a good forcing variety, and the most careful hand pollenation. The crop tabulated does not include all the tomatoes grown in the house, since there were a considerable number of plants fruited besides those in the variety test. The tomatoes which were sold brought 25 cents per pound, which is a fairly good price as compared with the market quotations in the Northern cities at wholesale. All that were sold, were sold in Raleigh and at the winter resorts in North Carolina, and many more could have been sold.

With a narrow, lean-to house, built especially for this purpose, we are of the opinion that the crop of winter tomatoes can be made a very profitable one here with the great increase in the patronage of our winter resort hotels in the sand-hill country.

The abounding sunshine which we usually have, even in the coldest weather, is a great advantage in winter forcing in this climate, and renders it possible to get better results at a lower cost than can be had in the North, with their long dark spells in winter, and their heavy snows, to say nothing of the greater amount of coal that is required by reason of the more severe climate.

Winter gardening is in its infancy in the upper South. Our

people have found that with the slight protection of cloth, they can grow very profitable crops of lettuce. With glass they can grow far better crops of this, and have the crop more secure. When once the gardener gets to using glass on simple frames, it is but a step to the more intensive work of forcing in heated structures. The competition of the South compelled the Northern gardeners to intensify under glass, until acres of land are now covered with forcing houses around all the great Northern cities. The competition of the tropics will soon compel the gardeners of the upper South to adopt to some extent the methods that have brought profit to the Northern gardeners. Therefore, as a contribution towards aiding in the work of using glass in gardening for the market, I have added a brief treatise on the use of glass, which I trust may be of value to those who realize the value of concentration of effort instead of the extensive methods that are generally used in the South.

It is proper to add here that all the work of the tomato experiment has been under the direction of my assistant, Mr. Alexander Rhodes, with the help of the following members of the Senior class in this department: Messrs. Bernhardt, Harrell, Hanff, Jones and Shore.

The Use of Glass in Market Gardening in North Carolina.

By. W. F. Massey.

INTRODUCTION.

The great development of market gardening in vegetables in the South Atlantic coast plain, and particularly in the part of North Carolina where the conditions of soil and climate, and the facilities for transportation of the products by rail and water, are so favorable, calls for greater skill on the part of the growers, and more intensive culture. Our people in all lines of soil culture are too much inclined to spread out over large surfaces, and to try to do things on a large scale. This tendency is an inheritance from the old cotton-planting days, and it is hard for Southern men to realize what may be done by intensive culture on a small area. Our market growers have mainly confined their attention to those crops like the early potato and cabbage and peas, which bring returns at once, and which require little special skill on the part of the grower. The result has been that at times the product of these things is so great that no one gets fair returns from his investment and labor. Years ago when the development of trucking in the South seemed to the gardeners near the large Northern cities to threaten the destruction of their business, they were compelled to turn their attention to a more intensive way of gardening, and to use glass in a skillful manner to produce crops of high quality out of the regular season. In this they have succeeded to such an extent that market gardening under glass has become an established industry near all the great cities of the North, and the profits from such intensive culture are far greater than any made in the open ground anywhere. Thus the Northern gardeners have been enabled to compete with the products from the far South and the tropics, by reason of the superior quality of the products thus grown, and their better condition when offered for sale. To such an extent has this culture under glass grown in the North that men

are now growing under glass, in the semi-arctic climate of Vermont, winter cucumbers and other vegetables for the New York and Boston markets, at points as distant from market as North Carolina, and under conditions far more expensive and difficult than any here. The Northern gardener under glass is compelled in many places to use double glazed sashes on his houses to exclude the cold, and far more expensive heating arrangements, and a great deal more of coal than would be needed in heated structures here. Our abounding sunshine, even in the coldest winter weather, and the absence of the long sunless spells with which the New England gardeners have to contend, would give us a vast advantage in greenhouse culture in winter. Then, too, the fact that crops like lettuce, which they grow in heated houses, can be produced here in simple frames and loose glass sashes in as great perfection as they grow the same in heated houses, gives us an advantage that we should not be slow in adopting.

With our growers, as soon as they begin to consider the matter of winter gardening, the first thing is to get something which they imagine is cheaper than glass. Our gardeners seem to think glass an exceedingly costly article. Hence, when they propose to grow lettuce, they make great wide beds and cover them with cloth, which is commonly kept on too constantly, thus really retarding the plants, and in these wide and high frames with the cloth cover, it is almost out of the question in severe spells to prevent serious damage from frost, which would not be the case in narrow, low, glass-covered frames. Instead of being cheaper, the cloth is, in the long run, far more expensive than glass, and when the difference between the crops is considered, it is the most costly from the start, because of the less profit that can be had from it. When snow falls, the cloth-covered frame is usually in a bad way, but on a glass-covered frame the snow is a protection from the cold wave that usually follows the snow fall. Then, too, with the glass we can grow more than one crop during the winter, and can use it for other crops besides lettuce, such as beets and radishes, and for the forwarding of the plants of tomatoes, egg plants and other things. When once the gardener gets skillful in the handling of simple sashes on a cold frame, the transition becomes easy to the greenhouse, and the heated hothouse for more tender

things. It is for the purpose of encouraging our people to acquire the necessary skill in gardening under glass that this bulletin is prepared. Products that require for their perfection the outlay of capital, and which are in the nature of a permanent investment, are always more certainly profitable than the crops that anyone can grow in the open ground, and which are, therefore, constantly liable to meet a glutted market. In the production of winter crops, as I have suggested, our growers have a decided advantage over those further North, and the margin between cost and the selling price will always be larger here, and will more than balance the cost of transportation. Just as the Southern cotton mills are successfully competing under more favorable conditions with those in the North, so our gardeners under glass, with our bright sun, can grow crops more cheaply and better than those in the dark winters of the North.

But the gardening under glass, requires more careful study and greater watchfulness than gardening in the open air, and it behooves us to gain by experience before branching out on too large a scale. When once a man who is in love with his calling, begins to grow better products than his neighbors he soon reaps his reward in better prices. The lettuce, for instance, which is grown under plant cloth, goes to market usually in barrels, and is sold as "Southern field lettuce," by the barrel. Lettuce grown well under glass and shipped in handy boxes is sold by the dozen at a higher price, and competes with the Northern greenhouse lettuce. The gardener with glass gets his lettuce into market at the Christmas holidays, and is ready at once to replant for a crop to compete on more favorable terms with the crop of the man who is using cloth, and as the spring crop usually sells for more than the mid-winter crop, his lettuce being in better condition, brings more money. I have gotten three times the price for lettuce the first of April that I got during the winter months, though the first paid very well. The many uses to which glass sashes can be applied is another argument for their use. After the lettuce crop is shipped the tomato plants are hardened off in the frames, and as after the first of March in this climate the lettuce does not need the glass, an extra set of frames can at once be used for the tomato plants that have been started in hotbed or greenhouse.

And after the tomato plants are removed to the field the very tender egg plant can be set in the frames, and protected during chilly nights, and thus brought on at a time when it will command a good price. Or a hill of cucumbers can be planted under each sash from plants started in pots in the greenhouse and brought on earlier than those in the open ground far south of us. Then after all the plants have used the glass, there is no better place for the drying of fruit in summer than under these same sashes. Those whose interest is in the strawberry crop, can use the sashes to cover strawberry plants set for this purpose in frames, and if the sashes are put over them the first of March or a little earlier the crop is rapidly advanced, and the blooms protected from frost, so that the fruit goes to market far ahead of the open-air crop.

Therefore, if you intend to adopt intensive gardening, and strive for the production of crops in winter, we would urge that you drop at once and forever the idea that plant cloth is cheaper or better than glass, for it is neither.

COLD FRAMES.

The name cold frame is applied to a simple frame set on rich soil, and covered with glass sashes. This name is to distinguish it from the hotbed in which a pit is dug under the frame and filled two feet deep with fermenting manure to heat the frame above. The hotbed soon becomes a cold frame as the heat of the manure dies out. Hotbeds are little used now-a-days by gardeners, because they are in the long run far more expensive than heated greenhouses, and far more laborious and troublesome to manage. The sashes for the cold frames should be of the regular size, three feet wide and six feet long. It has been found by long experience that this size is the most easily handled, and makes a bed more easily worked than larger or longer sashes. The sash being then six feet long, the frame to receive it will be nearly that width, and can be made as long as one chooses. The rows of frames in a framing ground should be far enough apart for a cart to go easily between each row. This will give room to pull off the sashes entirely on occasion, and room to get around with manure, etc. The frames are constructed of one and a quarter or one and a half-inch stuff, and should be 16 inches high at the back

or north side, and 12 inches on the south side, and should, of course, run east and west, with the slight slope of the glass to the south. Between each sash let into the sides with a dovetail on each end a three-inch strip of stuff, but do not nail it fast. Simply let it hold the sides together by the dovetails. On this strip nail an inch parting strip to form a slide for the sashes which rest on the first strip, which is flush with the top of the frame. Some gardeners have dispensed with the cross bars entirely, and fasten the sides of the frame firmly to posts, simply setting the sashes across from side to side. They claim that this is an advantage besides saving lumber, as the whole frame is clear, and they can use a horse in preparing the ground. But it will always take two hands to handle the sashes in this way, while with the slide one man can attend to the airing, and can give little or more as needed, and the cross-bars, being simply dovetailed, are easily knocked out while the ground is being prepared. We much prefer to use the cross-bars, and a further advantage is that the crack between the sashes is closed to the cold.

Sashes for frames should be made with a groove on the bars just deep enough to allow the glass to slide in end to end. This is a great saving as no puttying is needed, but care must be taken to fit the glass up close, and to drive a tack at the lower end to prevent the glass from sliding down. With glass put in in this way, if one is broken there is little trouble to slide the others up and put in a piece at the bottom, and the sashes are lighter and more easily handled than when puttied.

THE USES OF COLD FRAMES.

We have already in the introductory chapter told of some of the uses of cold frames. The main crop for which they will be used here is the lettuce crop. Lettuce needs a rich soil, but prefers quite a sandy one, and if the natural soil where the frames are located is not sandy it will be far better to excavate the whole to the depth of a foot, and replace the natural soil with a compost made by piling sods, manure and sand during the previous summer and turning the mass frequently so as to get it well rotted and homogeneous. If the soil is naturally sandy this will not be necessary. The frames should be gotten ready early in the spring, and the fertilizer needed by the

lettuce should be placed in the soil months ahead of the planting of the crop, for otherwise the commercial fertilizers are apt to burn the roots of the plants. A crop of radishes can be taken from the frames to pay for the work the first spring, and to get the soil ready for the fall planting of lettuce. If stable manure is to be used in the frames it should be well rotted and placed in the frames early in summer, and the soil should not be allowed to get weedy, but can be used for the production of cucumbers during the summer. Then in the fall a light dressing of cotton-seed meal will be all that is needed, and this should be well worked into the soil.

SOWING LETTUCE SEED.

The seed for the Christmas crop of lettuce should be sown the last of August or first of September, in a bed well enriched and prepared for the purpose. For this crop we use the Boston Market or Tennis Ball, a small-headed and compact growing sort, which can be planted more closely in the frames than the Big Boston, which does better for the second crop. In building cold frames always build twice as many as you have sashes, for in no other way can you use the glass so economically. The plants from the sowing of Boston Market the first of September, or the last of August, if the weather is better, will be ready to set in the frames in October or earlier. At the same time we sow the lettuce, we sow a bed with Snow Ball Cauliflower. These we set in October, six plants to each six-foot sash, and then fill in between them with lettuce, so that we have 40 plants of lettuce and 6 cauliflower plants, the cauliflower plants being set in two rows 18 inches from each other and 18 inches from the sides of the frame. As fast as the plants are set the bed is watered and the sashes placed over and shaded by throwing a little sand over the glass. As soon as the plants take hold of the soil the glass is removed and cleaned, and is not put on again till the nights are frosty, and during all sunny weather the glass is slipped down more or less so that the lettuce does not grow too soft and flabby, which will make it ship badly. By the time the lettuce is cut out, the cauliflower plants will be getting large, and should be gradually tempered to the outer air so that when the other frames are planted with lettuce the sashes can be taken off and the cauliflower left to complete its growth without glass, which will bring its heading time the last of March or first of April.

SECOND CROP OF LETTUCE.

The seed for the second crop should be that of the Big Boston or the Cal. Butter. The seed should be sown the latter part of September or early in October in a bed well sheltered from the cold winds, and as the cold increases the bed should have a light cover of rough manure, but not to hide the plants. This will be sufficient protection till they are needed in January or February. These varieties grow much larger than the Boston Market, and should have 12 inches of space for their full development. The same care is needed in the transplanting as with the fall planted crop, but the sashes will have to be kept on more continuously for a while. But in all cold-frame management remember that the bright sun, even in quite cold weather, raises the temperature in the frames, and there will always be need of a little air during sunshine in the coldest days. If snow falls let it lie, for the snow is almost always followed by a cold wave, and there is no better protection for the frames than a coat of snow on the glass. This second crop will come on in March, and as the lettuce will hardly need the glass after the first of March, it will be very convenient to have still other frames ready for tomato plants that should have been sown in January, and transplanted in the greenhouse, and are now ready for "spotting out" at intervals of four inches in the frames to get gradually hardened to the open air, and be ready for setting in the field the last of March or first of April. By giving the tomato plants plenty of room, and all the air admissible on sunny days, and finally full exposure at night, they will get tough enough to stand a little white frost, and the earlier the plants can be gotten out and survive, the earlier the crop will be. I have had tomatoes stand quite a frost unhurt, after careful hardening off in the frames.

If the tomatoes are out of the frames the first to middle of April, you should have a nice lot of egg plants or cucumbers in four-inch flower pots ready to take their places under the glass. If egg plants, then plant two to each sash, and if cucumber but one hill to a sash. Give air as needed in warm weather, and carefully cover in chilly weather and at nights, so long as it remains cool, finally giving full exposure when the soil all around remains warm at night. To keep

the sashes and frames at work in this way the gardener must have some glass in hotbeds or a fire-heated greenhouse. The greenhouse is far the best and most convenient. If a hotbed is used the frame is constructed as for the cold frame, and is placed over an excavation not less than two feet deep. This excavation is to be filled with fermenting manure prepared as we will describe, and covered with four inches of fine, rich soil, in which seeds are sown or plants transplanted. To prepare the manure for the hotbed you will need fresh horse or mule-stable manure, well mixed with straw or leaves. Oak leaves will be better than pine, as they hold the heat better. Pile the manure, and as soon as it begins to steam, turn it over and throw the outside to the inner part of the heap. When it heats again turn again. Turn about three times before using, and then pack it tightly in the excavation, tramping it evenly all over. Then, after the pit is full, place the soil over it, and set a thermometer in the soil, and put the sash on. Watch till the heat begins to decline from the first rank heat, and the mercury stands below 90, and you can sow the seeds of tomatoes. Have the bed ready in late January for this purpose. We prefer to sow the seed in shallow boxes, and set in the hotbed, a small box being sufficient to start plants for a large bed, and for a much larger cold frame in the second transplanting. A hotbed of but two sashes will start plants enough to take hundreds of sashes at the second transplanting. When the plants in the box are large enough to handle, transplant them in the bed, two inches apart, and then give all the air the weather will allow so that the plants do not grow too fast and tall. Should they be inclined to run up, then top them to make them stout. By careful attention to air the plants should be able to endure the cold frames by the first of March, and should be placed there about four inches apart each way, and gradually hardened off as we have said.

HOW TO BUILD A CHEAP GREENHOUSE.

For the gardener who only wishes to grow the crops we have named, and who does not intend to go into winter forcing under glass, but a small greenhouse will be needed. The house is to be used simply for the starting of plants to be afterwards used in the frames, and to take the place of the uncertain and laborious hotbed. Such a

house can be easily built by anyone who can handle a saw and hatchet. The best and cheapest plan is that first recommended by the late Peter Henderson, in his book on Gardening for Profit, a book that should be read by all market gardeners.

It is built by using the ordinary sashes 3 x 6 feet that are used on cold frames and hotbeds. The walls of the house are made by setting good, stout posts in the ground in parallel rows ten feet apart, and cutting them off at the height of four feet to receive a plate on which a gutter is constructed. The sashes are then attached in alternate pairs to the ridge pole, which is shaped to receive them. These alternate pairs of sashes are screwed fast to the ridge pole and the gutter to form the rafters to support the ridge. Alternating with these are pairs of sashes that are hinged to the gutter and loose at the top, where they are fastened down by an iron strap punched with holes to set on an iron pin in the ridge, so that they can be lifted and fastened open for ventilation. Benches are constructed on the inside, at a height of 18 inches below the glass at the eaves, on which soil can be placed or sand for pots to sit upon. This leaves a walk two and a half feet through the centre of the house. The house should run north and south, and at the north end it is extended into a shed in which the heating apparatus is placed. If the house is to be heated with a furnace and smoke flue it should not be longer than 50 feet, but if hot water is used the length may be doubled or more according to the capacity of the boiler. Heating with a flue is the cheapest method for a small house, but far the least satisfactory, as there will always be a difference in temperature between the two ends of the house, that near the furnace being the hottest. There is also trouble at times from the escape of gases from the most carefully made flue, so that, where the first expense can be accomplished, it is always best to use hot water, and to put in a boiler of such a size that future additions may be made from time to time, and the necessity for more room occurs, without increasing the boiler. It is far cheaper to heat a house with a boiler of greater capacity than is actually needed, so that there is never any necessity for hard firing. If the heating is done by a furnace and flue there must be an excavation made in the north end of the building deep enough to accommodate the furnace and ash pit, and to bring the crown of the furnace arch just below

the level of the floor of the house. The furnace should have a good-sized ash pit, and in inside area should be 18 inches wide by 30 inches deep so as to give a good grate surface. From the top of the rear end of the arch a flue should be constructed of brick in a nine-inch wall rising to the level of the floor, and then gradually rising for a distance of 15 feet from the furnace. From this point terra cotta tile six inches in diameter can be substituted for the brick, and the flue carried around the entire house on a gradual rise till it returns to the chimney on the opposite side of the north end from the furnace. At this point, the old practice was to make the chimney of four boards nailed together and set on end. But this is a dangerous practice, for in times of high winds and a strong draft, the fire may get around the hundred feet of flue and set fire to the building. Hence it is better to terminate the flue in brickwork and top off with an ordinary terra cotta pipe. A good cast-iron door and frame are needed for the furnace, and the entire front can be bought from those who deal in greenhouse structure. Hard coal should be used in the furnace, so that a slow fire can be maintained during the night without constant attention, and the furnace should be of sufficient capacity to allow of a good mass of coal. If wood is used, the furnace should be at least four feet deep, and the ash pit and grate will not be needed, the draft being regulated by an opening in the door. The flue in this case should be made of brick the entire length of the house as the blast from wood will be too much for the tile. A wood-burning furnace may be made perfectly effective, if of sufficient size to admit large logs that will burn slowly all night without attention, but will be far less effective and satisfactory than hard coal.

A novice in greenhouse work usually keeps too much heat on and pays too little attention to the ventilation in the hours of bright sunshine. A night temperature of 50 degrees is warm enough for most of the plants needed to be started early for the market garden, and in a flue-heated house the warm end, where there will be a temperature of 60 to 65 degrees will be the place for egg plants and other tender things. A little practice will soon enable a man of intelligence to manage plants under glass successfully, and he will find that a small fire-heated greenhouse is far better, and in the long run, cheaper, than the manure-heated hotbed.

Such a house can also be used for the winter-forcing of tomatoes, cucumbers and snap beans. For forcing tomatoes, the benches should be covered with a good rich soil, and drainage made by having the benches made in slats and cover them with sods before filling in the compost to prevent the earth sifting through. The plants should be grown from seed sown the last of August in the open air, and transplanted once before setting them in the house. They can be planted 15 inches apart along the sides of the house, and trained to single stems on wires a foot from the glass. Cucumbers are grown in a similar way, but need a higher temperature than the tomatoes. A crop of snap beans can be taken along the front of the bench before the tomatoes need all the room. The best variety for this purpose is an English sort called the Pride of the Market. It is of very quick growth and productive. We have grown them with great success with two plants each in a six-inch flower pot. For forcing tomatoes, a night temperature of 60 degrees is best, while cucumbers do better with a night heat of 70 degrees or over. The short American cucumbers should have their flowers pollenized by hand, but the long English cucumbers will grow to full size without pollenizing.

Forcing vegetables and fruits in winter successfully requires the highest skill of the gardener, and the novice had better go slow until he learns by experience, or had better work at the business a while under skillful instruction.

The following Bulletins have been heretofore issued by the Division of Horticulture and Botany, which are still available:

No. 112. Trucking in the South, pp. 70.

No. 129. Horticultural Experiments at Southern Pines, 1895, pp. 46.

No. 138. The San Jose Scale in North Carolina, pp. 14.

No. 147. A Study of Lettuces, pp. 8.

No. 149. The Apple in North Carolina, pp. 36.

No. 159. Horticultural Experiments at Southern Pines, in 1896, pp. 92.

No. 162. Farming in North Carolina, pp. 34.

No. 164. The Flora of North Carolina, pp. 80.

Others have been published, but are now out of print. Any of the above can be obtained on application to Dr. George T. Winston, Director of the North Carolina College of Agriculture and Mechanic Arts, Agricultural Experiment Station, West Raleigh, N. C.